IN THE SPECIFICATIONS

Please amend paragraph **[0001]** of the application as indicated:

[0001] This application is a divisional application with a priority claim to United States Patent Application Serial No. 09/928,769 filed on August 13, 2001, now United States Patent XXXXXXX, which claimed ~~claims~~ priority from United States Provisional Patent Application Ser. No. 60/229,134 filed on August 30, 2000.

Please amend paragraph [0012] as indicated:

[0012] Co-pending United States Patent Application Ser. No. 09/539,053 (the '053 application) filed on March 30, 2000, now United States Patent 6,470,264 ("the *Mollison*'264 patent") having the same assignee as the present application, and the contents of which are fully incorporated herein by reference, discloses a method of accounting for the distribution of shale and water in a reservoir including laminated shaly sands using vertical and horizontal conductivities derived from multi-component induction data. Along with an induction logging tool, data may also be acquired using a borehole resistivity imaging tool. The data from the borehole resistivity imaging tool give measurements of the dip angle of the reservoir, and the resistivity and thickness of the layers on a fine scale. The measurements made by the borehole resistivity imaging tool are calibrated with the data from the induction logging tool that gives measurements having a lower resolution than the borehole resistivity imaging tool. The measurements

made by the borehole resistivity imaging tool can be used to give an estimate of $V_{sh\text{-}LAM}$, the volume fraction of laminar shale. A tensor petrophysical model determines the laminar shale volume and laminar sand conductivity from vertical and horizontal conductivities derived from the log data. The volume of dispersed shale, the total and effective porosities of the laminar sand fraction as well as the effects of clay-bound water in the formation are determined.

Please amend paragraph [0013] as indicated:

[0013] The method of the ~~'053 application~~ the *Mollison* '264 patent is not readily applicable to reservoirs in which the sands may be intrinsically anisotropic without making additional assumptions about the sand properties. Sands in turbidite deposits commonly comprise thin laminae having different grains size and/or sorting: the individual laminae may be isotropic but on a macroscopic scale relevant to logging applications, the laminations exhibit transverse isotropy. In addition, a reservoir including turbiditic sands exhibits an anisotropic permeability. Being able to determine this anisotropic permeability is important from the standpoint of reservoir development. This is an issue not addressed in the ~~'053 application~~ *Mollison* '264 patent and of considerable importance in development of hydrocarbon reservoirs.

Please amend paragraph **[0019]** as indicated:

[0019] Fig. ~~**2**~~ **2A** is a schematic external view of the unified borehole sidewall imager system. This may be used to provide the data that may be used in an optional embodiment of the invention. The tool **10** comprising the imager system includes four important components: 1) resistivity arrays **26**; 2) electronics modules **28** and **38**; 3) a mud cell **30**; and 4) a circumferential acoustic televiewer **32.** All of the components are mounted on a mandrel **34** in a conventional well-known manner. The outer diameter of the assembly is about 5.4 inches and about five feet long. An orientation module **36** including a magnetometer and an inertial guidance system is mounted above the imaging assemblies comprising resistivity array **26** and televiewer **32.** The upper portion **38** of the tool **10** contains a telemetry module for sampling, digitizing and transmission of the data samples from the various components uphole to surface electronics **22** in a conventional manner. Preferably the acoustic data are digitized although in an alternate arrangement, the data may be retained in analog form for transmission to the surface where it is later digitized by surface electronics **22.**

Please amend paragraph [0020] as indicated:

[0020] Also shown in **Fig.** ~~**2**~~ **2A** are three resistivity arrays **26** (a fourth array is hidden in this view). Referring to ~~**Figs. 2 and 2A**~~ **Fig. 2B**, each array includes 32 electrodes or buttons identified as **39** that are mounted on a pad such as **40** in four rows of eight electrodes each. Because of design considerations, the respective rows preferably are

staggered as shown, to improve the spatial resolution. For reasons of clarity, less than eight buttons are shown in **Fig. 2A.** For a 5.375" diameter assembly, each pad can be no more than about 4.0 inches wide. The pads are secured to extendable caliper arms such as **42.** Hydraulic or spring-loaded caliper-arm actuators (not shown) of any well-known type extend the pads and their electrodes against the borehole sidewall for resistivity measurements. In addition, the extendable caliper arms **42** provide the actual measurement of the borehole diameter as is well known in the art. Using time-division multiplexing, the voltage drop and current flow is measured between a common electrode on the tool and the respective electrodes on each array to furnish a measure of the resistivity of the sidewall (or its inverse, conductivity) as a function of azimuth.

Please amend paragraph **[0028]** as indicated:

[0028] In this invention, the terms "horizontal" and "vertical" are to be understood in terms of reference to the bedding planes and the anisotropy axes of the subsurface formations, i.e., "horizontal" refers to parallel to the bedding plane, and "vertical" refers to vertical to the bedding plane. Where the beds of the formation are dipping, the anisotropy axis is taken to be the normal to the bedding plane. When the borehole is inclined to the bedding plane, data from the orientation module **36** in ~~**Fig. 1**~~ **Fig. 2A**, may be used to correct the resistivity measurements made by the resistivity imaging tool to give measurements parallel to and perpendicular to the bedding planes.

Please amend paragraph **[0030]** as indicated:

[0030] Referring now to ~~**Fig. 4**~~ **Figs. 4A and 4B,** one optional embodiment of the invention starts with data acquired by a borehole resistivity imaging tool such as is described in United States Patent 5,502,686 issued to *Dory* et al., and the contents of which are fully incorporated here by reference. It should be noted that the *Dory* patent is an example of a device that can be used for obtaining measurements borehole resistivity measurements: any other suitable device could also be used. The process of the invention starts with an initial model **101** for the structure of the reservoir. This initial model comprises a laminated shale fraction and a sand fraction. This initial model may be derived from the resistivity imaging tool described above. A horizontal and vertical conductivity $C_{sh\text{-}lam,h}$ and $C_{sh\text{-}lam,v}$) of the shale fraction is assumed or is measured **103**; if measurements are to be made within a borehole, this may be done by using a Transverse Induction Logging Tool (TILT) on a thick section of shale in proximity to the reservoir. The resistivity of the "bulk" shale may also be obtained from core measurements.

Please amend paragraph **[0034]** with as indicated:

--**[0034]** As described in the *Mollison* ~~'053~~ '264 patent and the '967 application ~~applications~~, measurements $R_{t,h}$ and $R_{t,v}$ made by TILT or other suitable device **109** are inverted **111** to give an estimate of the laminar shale volume and the sand conductivity, assuming that the sand component is isotropic. In terms of resistivity,

$$R_{sd} = \frac{1}{2} \cdot \left\{ \left(R_{sd}^{iso} + R_{sh-l,m} \right) + \left(R_{sd}^{iso} - R_{sh-l,v} \right) \cdot \sqrt{(1 + \Delta R)} \right\} \quad (5)$$

where

$$R_{sd}^{iso} = R_{t,h} \cdot \frac{R_{t,v} - R_{sh-l,v}}{R_{t,h} - R_{sh-l,h}} \quad \Delta R = 4 \cdot R_{sd}^{iso} \cdot \frac{R_{sh,v} - R_{sh-l,h}}{\left(R_{sd}^{iso} - R_{sh-l,v} \right)^2} \quad (6)$$

R_{sd}^{iso} is the 'isotropic' sand resistivity. If the shale is isotropic, ($R_{sh,h} = R_{sh,v}$), then this resistivity is identical to the sand resistivity. ΔR is the correction for anisotropic shale. ΔR becomes zero for an isotropic shale ($R_{sh,h} = R_{sh,v}$).

Please amend paragraph **[0038]** as indicated:

[0038] If the answer at **117** is "No", then this is an indication that the sands component is anisotropic **121**. In this case, the TILT resistivity data are inverted **123** using the value of $V_{sh\text{-}l,\ TS}$ obtained at **107**, e.g., using Thomas-Stieber and the method of the '049 application or the method of the '053 application, to give a water saturation S_w and bulk volume of hydrocarbons **125**.

Please amend paragraph [0040] as indicated:

[0040] The sand anisotropy with resistivity values $R_{sd,h}$ and $R_{sd,\ v}$ is indicative of a laminated sand layer. These values of $R_{sd,h}$ and $R_{sd,\ v}$ are inverted to give a layered model

131 comprising isotropic sand layers and the laminated shale component determined above. In order to perform this inversion, an estimate of the number and thicknesses of the sand layers is required. This may be obtained from a resistivity imaging tool as discussed in the *Mollison* ~~'053~~ 264 patent and '967 application ~~applications~~ or it may be obtained using NMR data **127**. From the distribution of relaxation times T_1 and T_2 of NMR data, a distribution of volume fractions of individual sand components **133** may be obtained using known methods. Alternatively, core information or sedimentologic information about the reservoir may be used to give the volume fractions of the sand components.

Please amend paragraph **[0042]** as indicated:

[0042] Using assumed values for the water saturated sand in horizontal and vertical direction $R_{0,sd,h}$ and $R_{0,sd,v}$ the water saturation of the individual sand layer $S_{w,i}$ (i-th layer) are calculated separately ~~135~~ 137 using the layer resistivity $R_{sd,i}$ obtained at **131**. Depending on the saturation equation (Archie-equation, Waxman-Smits- equation) the following parameters are necessary as input 135: (i) Formation water resistivity, (ii) porosity or formation factor of the layer, (iii) saturation exponent of the layer, and, (iv) Waxman-Smits-parameters in case of dispersed shale in the sand layer.

Please amend paragraph **[0062]** as indicated:

[0063] Fig. 7a shows the relationship **301** between BVI_c and BVI_f for a range of assumptions of Vc between 0.1 and 0.6, i.e., all the solutions fit the measured resistivity values R_v and R_h.

Please amend the Abstract as indicated:

The ~~present invention is method of determining the~~ distribution of shales, sands and water in a reservoir including laminated shaly sands using vertical and horizontal conductivities is derived from nuclear, NMR, and multi-component induction data. The multicomponent ~~such as from a Transverse Induction Logging Tool (TILT). Making assumptions about the anisotropic properties of the laminated shale component and an assumption that the sand is isotropic, the TILT~~ data are inverted and an~~. An~~ estimate of the laminated shale volume from this inversion is compared with an estimate of laminated shale volume from nuclear logs. The ~~using a Thomas-Stieber and Waxman-Smits model. A difference between the two estimates is an indication that the sands may be anisotropic. A check is made to see if a~~ bulk water volume determined from the inversion is compared with ~~greater than~~ a bulk irreducible water volume from NMR measurements. ~~In one embodiment of the invention,~~ NMR data are then used to obtain a sand distribution in the reservoir and this ~~This~~ sand distribution is used in a second inversion of the ~~TILT~~ multicomponent data. Alternatively ~~, assuming that the sand comprises a number of intrinsically isotropic layers, to give a model that comprises laminated sands including water and dispersed clay, laminated shales and clay bound water. In another~~

~~embodiment of the invention~~, a bulk permeability measurement is used as a constraint in inverting the properties of the anisotropic sand component of the reservoir. From the resistivities of the sand laminae, empirical relations are used to predict anisotropic reservoir properties of the reservoir.